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Integrated Monitoring of a New Group B Streptococcal Disease Prevention Program and Other Perinatal Infections

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Objective: To determine levels of prenatal screening for several infections, intrapartum recognition of risk factors, and prophylaxis against mother-to-child transmission of group B streptococcus. *Methods*: Review of stratified random sample of hospital records for deliveries in Connecticut during 1996. SUDAAN analysis was used to adjust for the complex survey design, and weighting adjusted for the probability of being sampled and nonresponse. *Results*: Of 992 records requested, 868 (88%) were abstracted and analyzed. Thirty-six percent of women had prenatal screening for group B streptococcus and 26% had been tested for human immunodeficiency virus (HIV), while 97–99% of women had been screened prenatally for hepatitis B surface antigen, rubella, and syphilis. Of those women tested, 17% were detected as group B streptococcus carriers, and 78% of these received intrapartum antibiotic prophylaxis. Among women who were not screened for group B streptococcus prenatally, 22% met risk-based criteria for prophylaxis, but only 45% of these received intrapartum prophylaxis. Among unscreened women with a risk factor, those with shorter hospital stays prior to delivery, admitted on evening or night shifts, or who delivered on the weekend were significantly less likely to receive intrapartum prophylaxis. *Conclusion*: In 1996, the majority of women who delivered in Connecticut were not tested prenatally for group B streptococcus and the majority of those not tested in whom there was an indication for prophylaxis were not treated. Compliance with group B streptococcus prevention recommendations can be improved through increased prenatal testing and/or better recognition of risk-based criteria for intrapartum prophylaxis.

KEY WORDS: prenatal screening; group B streptococcus; survey design; human immunodeficiency virus; congenital infection.

INTRODUCTION

Mother-to-child transmission of infectious agents continues to occur, but many of these infections can now be prevented through appropriate use of antimicrobial and antiviral agents or vaccines. Current preventive strategies for perinatal group B streptococcal disease require provision of antibiotics to high risk women during labor. Women are designated high risk on the basis of one of two consensus strategies recommended by the Centers for Disease Control and Prevention (CDC), American College of Obstetricians and Gynecologists, and American Academy of Pediatrics (1–3). A screening-based strategy identifies women at risk through prenatal screening cultures collected at 35–37 weeks gestation. A risk-based strategy identifies candidates for antibiotic prophylaxis on the basis of obstetric complications evident at the time of labor or membrane rupture. Although previous surveys of practitioners and

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institutions suggested a variable degree of adoption of these prevention strategies (4–11), policies reported by health care providers or hospital authorities may not reflect actual practice. Further, surveys of physicians often suffer from low response rates, which may compromise their representativeness. Sampling medical records can provide more objective evidence of adoption of prevention measures.

The Emerging Infections Program of the Connecticut Department of Public health, in collaboration with the CDC, sought to promote prevention of perinatal group B streptococcal disease through a multiyear demonstration project. The initial phase of the program aimed to measure actual prevention practices during 1996, the year the consensus strategies were issued, and to identify predictors of women who did not receive intrapartum antibiotic prophylaxis despite having indications for their use. The findings were intended to direct subsequent educational sessions and the survey methods aimed to serve as a model for integrated tracking of perinatal prevention programs in the state, and potentially in other areas as well. The study found that a simple survey design could provide locally useful data on new group B streptococcal disease program areas while simultaneously measuring compliance with longer-term screening programs for rubella, syphilis, hepatitis B, and human immunodeficiency virus (12).

METHODS

Sample Design

The sampling method was designed to enhance evaluation of women delivering preterm because prevention practices for group B streptococcus differ for women delivering before 37 weeks. A stratified random sample of 992 births was selected using the power allocation method (13), requiring a minimum sample of 20 births per hospital from all singleton births during 1996 in the state ($n = 43{,}109$). Ninety strata were formed on the basis of hospital of birth ($n = 30$) and term of birth according to the categories full term (37 or more completed weeks' gestation or at least 259 days), preterm (less than 37 completed weeks' gestation), or unknown term. Within each stratum, births were selected by simple random sample. From the original 992 births, we were unable to abstract charts of 123 (12.4%) delivering mothers, and an additional record had no information on term of delivery and so was also excluded, leaving 868 records available for analysis. Within each stratum, a constant weight was assigned to each sample element. The adjustment for nonresponse assumes records located within each stratum are representative of those records not located. The sample weight was based on the inverse probability of selection and was adjusted to account for the 12.4% nonresponse (i.e., those charts that were not abstracted). The sum of the final sample weights reflect the number of singleton births in Connecticut in 1996.

Data Collection

Three trained abstracters collected demographic and clinical information from maternal records available at the delivery hospital using a one-page data collection form. We collected information on prenatal screening specimens obtained for group B streptococcus, HIV, hepatitis B surface antigen, rubella and syphilis, as well as administration of intrapartum antibiotics. We also collected clinical data on the presence of the criteria used to identify women for intrapartum antibiotics according to the risk-based strategy for group B streptococcus prevention (i.e., gestation less than 37 weeks; rupture of the membranes 18 h or more; intrapartum temperature at least 100.4°F or 38°C; group B streptococcus bacteriuria; previous infant with group B streptococcal disease). The gestational age of the last prenatal visit for which records were available in the delivery chart was also recorded.

Analytic Methods

All analyses were conducted using the sample weights to account for the unequal probability of selection. The data were analyzed in SUDAAN to account for the stratified survey design (14). We used the Kessner Index (15) to determine adequacy of prenatal care visits. Comparison of proportions was performed using the Wald chi-square test. Relative risks and 95% confidence intervals (CI) were calculated by the logit method. All reported percentages were adjusted for the sample weights to reflect the occurrence of these factors among all Connecticut births during 1996.

In addition to descriptive characteristics of prenatal screening for the five perinatal infections among Connecticut deliveries in 1996, we conducted univariate and multivariable analysis of factors associated with a) being screened prenatally for

Table I. Prenatal Screening and Follow-Up for Selected Perinatal Infections Among Women Who Delivered in Connecticut During 1996

Infectious agent or test	% Tested	Test results[a]	% At risk followed appropriately[b]	Projected number of infants born in CT exposed to pathogen or, for rubella, not immune
Group B streptococcus	36	17% positive	78	7329 GBS positive[c]
Human immunodeficiency virus	26	ND[d]	ND	ND
Syphilis	99	0.34% positive	100	145 infants at risk for congenital syphilis
Rubella	99	3.76% susceptible	89	1660 infants at risk for congenital rubella
Hepatitis B surface antigen	97	0.48% positive	ND	203 infants at risk for perinatal hepatitis B

[a]Of those tested.
[b]Appropriate follow-up defined: for GBS positive women, receipt of intrapartum antibiotics; for women with positive VDRL or RPR, prenatal treatment with penicillin; for rubella-susceptible, provision of postpartum rubella vaccine before discharge.
[c]Assumes all women are tested; if only 36% of women are tested, 2690 GBS-positive women would be identified.
[d]ND: not determined.

group B streptococcus and b) receiving intrapartum antibiotics among those with indications. Factors that had p values <0.15 in univariate analysis were incorporated into multivariable models, which used manual and backwards elimination techniques to reach final models. In separate analyses we evaluated factors associated with GBS colonization, after restricting the analysis to women who had prenatal test results for group B streptococcus documented. These models included demographic factors (e.g., race, maternal age), socioeconomic factors (e.g., Medicaid vs. private insurance) clinical features (e.g., gestation < 37 weeks), and characteristics of the health services (e.g., day and shift of admission or delivery, type of health care practitioner providing prenatal care, time interval between hospital admission and delivery).

Study Approval

Medical record review and data collection were approved by the Connecticut Hospital Association. Project activities were also approved by the CDC Institutional Review Board.

RESULTS

We analyzed data for 868 births, or 2% of the 43,109 singleton births in Connecticut residents that occurred at hospitals within the state in 1996. One record was excluded because of lack of available information on term of birth. All percentages that follow reflect weighted data for Connecticut deliveries.

Seventy-nine percent of women were white, 12% of women were African American, and 7% were of unknown race. Hispanic ethnicity was noted in 13% of parturient women. Only 7.5% of deliveries occurred to women less than 20 years of age, and 9.0% of deliveries occurred preterm. Prenatal care was intermediate or adequate in 97% of deliveries (31.5 and 65.9% respectively).

Prenatal Screening

During 1996, prenatal patients were not often screened for HIV (26% of births), while nearly all were screened for syphilis (99%), rubella (99%), and hepatitis B surface antigen (97%) (Table I). Prenatal collection of group B streptococcal cultures was documented in 36% (95% CI 33–40%) of deliveries. Women whose delivery record included information regarding a prenatal visit at 34 weeks' gestation or later were more likely to have prenatal group B streptococcal cultures collected compared with those whose last documented prenatal visit occurred earlier (42 vs. 27%, $p = 0.001$). Prenatal group B streptococcal screening was also more likely to occur in women who were tested for HIV (46 vs. 34%, $p < 0.01$). Prenatal screening for group B streptococcus was not associated with maternal age, race, ethnicity, or insurance status.

Of the 339 women with documentation that group B streptococcal prenatal cultures were collected, results were located in the hospital charts for 338 (99%). Seventeen percent of women screened were found to carry group B streptococcus. Among those screened for group B streptococcus, colonization was significantly more likely among those who delivered before 37 weeks (31.4 vs. 15.7%; relative risk 2.0; 95% CI 1.1, 3.7). While group B streptococcal colonization was more common among screened women who were African American compared with white (24.9 vs. 17.3%), the difference did not reach statistical significance ($p > 0.05$).

Risk Criteria for Group B Streptococcal Prophylaxis

Rupture of membranes 18 h or more before delivery was noted for 9% of women, and a similar percentage delivered before 37 weeks' gestation. Intrapartum temperature greater than 100.4°F was evident in 4.4%, group B streptococcal bacteriuria in 1.7%, and a history of a previous infant with group B streptococcal disease was noted in the records for 0.31% of deliveries. We estimate that at least one risk factor (i.e., prolonged rupture of the membranes, preterm delivery, intrapartum fever, group B streptococcal bacteriuria, or previous infant with group B streptococcal disease) was evident in 21.8% of all Connecticut deliveries (based on 287 of the 868 records sampled).

Intrapartum Antibiotic Use

Intrapartum antibiotics were administered in 15.2% of all deliveries in Connecticut in 1996. Ampicillin was used more frequently than penicillin or other agents; 10.9% of women who delivered in 1996 received intrapartum ampicillin compared with 2.9% who received penicillin.

Among women with positive prenatal screening results for group B streptococcal colonization, 78% (95% CI 67–89%) received intrapartum antibiotics (Table II). Intrapartum antibiotics were more likely to be administered to African Americans than to whites (97 vs. 75%, $p = 0.006$), and to patients with private insurance, compared with those covered by Medicaid (89 vs. 57%, $p = 0.05$). Compared with group B streptococcus-positive whites who were not on Medicaid, group B streptococcus-positive whites on Medicaid were less likely to receive intrapartum prophylaxis (27 vs. 85%, $p = 0.0002$), while group B streptococcus-positive blacks on Medicaid were more likely to receive intrapartum prophylaxis (100 vs. 85%, $p = 0.0186$). Group B streptococcus-positive blacks and whites who were not on Medicaid received intrapartum prophylaxis with similar frequency. There were no significant differences in intrapartum antibiotic use among prenatal carriers on the basis of maternal age, gestation, provider type, or interval in the hospital before delivery. Among women who were group B streptococcus carriers, admission during the evening shift was associated with higher compliance with intrapartum antibiotic administration.

There were 173 (21.8%; 95% CI 18–26%) women in the audit who were not screened for group B streptococcus prenatally but who had one of the risk criteria for intrapartum prophylaxis. Of these, 45% (95% CI 34–56%) received intrapartum prophylaxis. Intrapartum antibiotics were more likely to be administered to high risk unscreened women when delivery occurred before 34 weeks (68 vs. 31% for deliveries at 34–36 weeks and 43% for deliveries at 37 weeks or more, $p = 0.03$) (Table III). No association between maternal age, race, or ethnicity and intrapartum antibiotic administration was detected. The shorter the interval in the hospital before delivery, the less likely it was for the antibiotics to be administered (16.7 vs. 55.7% with intervals less than 8 vs. 8 or more hours before delivery, $p < 0.0001$). Among women with obstetric risk factors, those admitted in the evening or night shift were less likely to receive intrapartum antibiotics (34 vs. 57%, $p = 0.03$). Women who delivered on the weekend were also less likely to receive intrapartum antibiotics (25 vs. 53%, $p = 0.009$).

Table II. Indications for Intrapartum Antibiotics According to the Screening- or Risk-Based Approach to Group B Streptococcal Prevention and Proportion of Those With Indication Who Received Intrapartum Prophylaxis

Criteria	Percentage of all Connecticut deliveries	Percentage of those with criteria who received intrapartum antibiotic prophylaxis
Screening-based strategy:		
Prenatal group B streptococcus culture positive	17[a]	78
Either strategy:		
GBS bacteriuria during the current pregnancy	1.7	65
Previous infant with GBS disease	0.31	76
Risk-based strategy:		
Delivery at <37 weeks	9.0	53
Rupture of membranes ≥18 h	9.2	45
Intrapartum temperature ≥100.4°F (38°C)	4.4	47
At least one risk factor (except positive culture)	21.8	45

[a]36% of all women were screened prenatally and 17% of those tested had group B streptococcus isolated; 6.2% of all deliveries were documented to have group B streptococcus colonization.

Table III. Factors Associated With Receipt of Intrapartum Prophylaxis Among 173 Unscreened Women With One or More Risk Factor[a]

Characteristic	% Receiving intrapartum prophylaxis	Relative risk (95% CI)	*P* value
Maternal age			
Less than 20 years	40.3	0.88 (0.40, 1.95)	0.75
20 years or more	45.6	Reference	
Gestation			
Less than 34 weeks	67.9	1.57 (1.01, 2.45)	0.03
34–36 weeks	31.3	0.73 (0.41, 1.29)	0.27
37 weeks or more	43.2	Reference	
Time from admission to delivery			
Less than 8 h	16.7	0.30 (0.14, 0.64)	<0.0001
8 h or more	55.7	Reference	
Admission shift			
Night or evening shift	34.3	0.60 (0.37, 0.99)	0.03
Day shift	56.7	Reference	
Day of delivery			
Weekend	25	0.47 (0.22, 0.98)	0.009
Weekday	53	Reference	

[a] Risk factors include gestation less than 37 weeks, rupture of membranes 18 h or more, intrapartum temperature greater than or equal to 100.4°F, group B streptococcal bacteriuria, or previous infant with group B streptococcal disease.

Women who were detected as group B streptococcus carriers prenatally were more likely to receive intrapartum antibiotics than were unscreened women who presented in labor with one of the risk criteria for prophylaxis (78 vs. 45%, $p = 0.0001$)(Table II).

Compliance With Interventions to Prevent Other Congenital Infections

We identified 0.34% of women who delivered infants in CT in 1996 as having positive VDRL or RPR test results; all of these women were treated with penicillin during their pregnancies. Of the 3.76% of CT mothers who were susceptible to rubella infection, 11% failed to receive rubella vaccination before discharge from the hospital after delivery.

DISCUSSION

Health departments, managed care organizations, and individual obstetric caregivers frequently choose among competing priorities to apply limited resources toward disease prevention, and infections are only one of many pregnancy complications for which prevention efforts can have documented benefit. Using a simple tracking method, we determined the status of prenatal screening for group B streptococcus, hepatitis B surface antigen, HIV, rubella, and syphilis among deliveries in Connecticut. The survey demonstrated that prenatal screening was virtually universal for rubella, syphilis, and hepatitis B, whereas the vast majority of women were not being tested for either HIV or group B streptococcus during 1996. Screening for HIV and group B streptococcus was correlated, suggesting that prenatal caregivers who might benefit from outreach efforts regarding prenatal HIV testing and counseling are generally the same ones who will benefit from education regarding group B streptococcus testing. While the prevention program for perinatal hepatitis B transmission in Connecticut was quite mature in 1996, outreach efforts were appropriately redirected to focus on HIV and group B streptococcus. However, by expanding a group B streptococcus birth audit tool to include information on several infections, the health department was able to continue to monitor screening practices for hepatitis B at minimal cost. In addition to prenatal testing, our study also assessed follow-up of abnormal screening results for rubella and syphilis and found that many women susceptible to rubella did not have documentation of postpartum rubella vaccination. Consistent with these findings is the occurrence of outbreaks of rubella among adults in Connecticut in 1995 and 1998. In contrast to postpartum rubella immunization, follow-up efforts for prevention of congenital syphilis cases during 1996 appear to have been comprehensive. Of note, prenatal syphilis testing was the only infection screening test mandated in the state of Connecticut during 1996.

Our survey focused on prenatal and intrapartum prevention practices during 1996, the same year that CDC and ACOG issued consensus group B streptococcal prevention guidelines. These data provided a baseline of practices before the health department initiated outreach efforts as part of a group B streptococcal prevention demonstration project. In contrast, Connecticut had been promoting prevention of perinatal hepatitis B since 1992, consistent with the audit's finding that nearly all women had prenatal hepatitis B surface antigen testing during prenatal care. HIV testing and counseling were not widespread during 1996, but this survey provided critical baseline data by which the health department could gauge progress toward achieving targets set for Ryan White programmatic funding (12). While health departments have become increasingly dependent on categorical funding for routine operations, this project demonstrated the value of integrating prevention tracking for

multiple conditions. Consistent with this goal, Connecticut added assessment of toxoplasmosis testing to a birth audit performed during 2000, and perinatal HIV prevention program personnel in other states are considering use of a modified version of this survey tool to track HIV testing and counseling efforts.

We found that only 36% of women who delivered in Connecticut during 1996 had received prenatal group B streptococcal screening cultures. Because prevention statements from CDC and ACOG were published in May and June of 1996, and the statements recommended use of either a prenatal screening strategy or a risk-based strategy that did not use prenatal cultures, this proportion must be interpreted carefully. The actual proportion of women being tested for group B streptococcus may have been higher than the 36% we documented if some women who were tested failed to have their testing documented in the hospital delivery record. In addition, we found that prenatal group B streptococcus testing increased over the course of 1996, with testing documented in 30% of deliveries during the first 6 months of 1996 compared with 43% of deliveries in the second half of the year ($p = 0.0022$). By 1997, 68% of institutions in Connecticut that had policies for group B streptococcal prevention reported having adopted the screening-based approach (9), and in 1998, 72% of obstetric caregivers surveyed reported that their practices had adopted the screening approach (10). It is therefore quite likely that the proportion of women delivering in Connecticut who are being screened for group B streptococcus prenatally is now much higher than the estimate for 1996. Because prenatal screening is dependent on appropriate processing of specimens, the Connecticut Department of Public Health completed outreach to all microbiology laboratories in the state and has documented an increase in the use of selective broth media from 62% in 1997 to 100% in 1999 (16). Conformance with recommended laboratory methods is likely to increase the effectiveness of the screening strategy.

Intrapartum antibiotics are highly effective at prevention of mother-to-child transmission of group B streptococcus. We determined that women with group B streptococcus detected in prenatal screening cultures were more likely to receive intrapartum prophylaxis than were women who were not screened but presented one of the other risk factors. The results of this study were used to guide outreach efforts carried out by the Connecticut Department of Public Health, in collaboration with the Connecticut chapter of ACOG and other obstetric authorities in the state. Recognition of intrapartum complications as indications for group B streptococcal antibiotic prophylaxis may be more difficult than responding to prenatal culture results. Additionally, complications may occur shortly before delivery (e.g., prolonged rupture of membranes), precluding timely administration of antibiotics. Compliance with intrapartum prophylaxis for unscreened women with risk factors was quite similar to that recently documented in a managed care population (17).

Our results of group B streptococcal prevention practices in 1996 can be contrasted to data from other sources available for Connecticut during this time period. Of note, hospital and provider surveys suggested that screening was the preferred method of group B streptococcal prevention in Connecticut, yet only 36% of deliveries evaluated had documentation of prenatal screening (10). A multistate survey suggested that penicillin was the first line prophylaxis agent for 60% of hospitals in 1997 (9). We found that 71% of women who received intrapartum antibiotics in Connecticut in 1996 received ampicillin, compared with 19% who received penicillin. It is possible that much of the intrapartum antibiotic use we documented was prescribed for therapeutic indications (e.g., maternal amnionitis) rather than for group B streptococcal prophylaxis. Follow-up data on antibiotic use in Connecticut after increased uptake of group B streptococcal prevention practices may clarify these results. It is also possible that policies reported by clinicians and hospital authorities differ from their actual practices. In consideration of the difficulty and cost of obtaining representative samples from practitioner surveys, and the burden that multiple surveys place on providers, we believe that the birth audit method is likely to be an accurate, efficient, and acceptable means of measuring a variety of prevention practices in obstetric care.

The methods we employed are relatively inexpensive and flexible, and may be applicable for other maternal child health programs. Yet certain limitations of this approach bear mention. Review of maternal hospital records may be incomplete for certain prenatal information, particularly those which are collected late in pregnancy after charts are forwarded to the delivery site. Furthermore, some information is available to clinicians at delivery but not recorded in the hospital record, particularly in facilities where computerized laboratory data or logbooks are routinely checked by caregivers but not printed out for inclusion in medical records. This survey did not include review of infant records, which may be necessary

to assure detection of certain neonatal exposures. Finally, the sampling method we employed requires familiarity with SUDAAN or other analytic software for complex surveys. Although clinical record review has many important limitations, because of inconsistencies or omissions in documentation on medical records, it provides important advantages to other approaches. Surveying providers or their institutions can suffer from response bias, and surveys of health care providers typically reach low response rates. Direct observation of providers can inadvertently lead to changes in practices (i.e., the Hawthorn effect).

Studies of the relative merits of the risk- versus the screening-based approach to group B streptococcal prevention, thus far based solely on theoretical effectiveness of the two strategies, have suggested that the screening-based strategy identifies a higher proportion of women whose infants will develop early-onset disease as candidates for intrapartum prophylaxis (18). This study suggests that in Connecticut during 1996, practitioners recognized positive group B streptococcus results as an indication for intrapartum prophylaxis more readily than they recognized obstetric risk factors. In particular, failure to give intrapartum prophylaxis on nights and weekends to persons with risk factors but not those with positive group B streptococcus cultures suggests that clinical signs may be insufficient to stimulate group B streptococcal preventive action. In recognition of both the theoretical and practical advantages of screening in Connecticut, in May 1999 the Connecticut Department of Public Health notified obstetricians and nurse-midwives in the state that the screening-based approach to prevention should be preferentially adopted. The Centers for Disease Control and Prevention continues to recommend adoption of either strategy, and is currently undertaking an evaluation of the comparative effectiveness of the two approaches in actual practice in additional states.

We found moderate compliance with group B streptococcal prevention recommendations among deliveries in Connecticut in 1996, with 36% of women receiving prenatal testing and 78% of those positive appropriately receiving intrapartum prophylaxis. Among the 22% of women who were not screened but who manifested one of the risk-based criteria for prophylaxis, only 45% actually received antibiotic prophylaxis. Follow-up efforts conducted by the Perinatal Infection Prevention Unit of the Connecticut Department of Public Health focused on reminding practitioners of indications for prophylaxis according to the risk-based approach, and improving documentation of prenatal testing among those following the screening-based approach. The incidence of early-onset group B streptococcal disease has declined from 0.61 cases per 1000 births in 1996 (9) to 0.23 cases per 1000 births in 1999 (19), suggesting that these efforts may be having a measurable impact on disease.

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